

STUDENT NUMBER

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Letter

ENVIRONMENTAL SCIENCE

Written examination

Friday 6 November 2015

Reading time: 11.45 am to 12.00 noon (15 minutes)

Writing time: 12.00 noon to 2.00 pm (2 hours)

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	30	30	30
B	6	6	90
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

- Question and answer book of 26 pages.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Question 1

Which one of the following is a significant greenhouse gas?

- A. helium
- B. nitrogen
- C. methane
- D. carbon monoxide

Question 2

Which one of the following is a non-fossil, non-renewable energy source?

- A. wind
- B. nuclear
- C. geothermal
- D. hydro-electric

Question 3

A new type of fuel cell operates by the catalytic breakdown of a complex organic compound.

Each kilogram of this compound contains 20 000 kJ of chemical energy and produces 4000 kJ of electrical energy.

The efficiency of this fuel cell is approximately

- A. 0.20%
- B. 16%
- C. 20%
- D. 80%

Question 4

Fuel cells need to be kept cool during operation.

This is most likely because

- A. the reaction in the fuel cell is exothermic.
- B. the reaction in the fuel cell is endothermic.
- C. fuel cells only operate satisfactorily at very high temperatures.
- D. at higher temperatures, fuel cells produce a toxic waste product.

Question 5

Which of the following substances combine to form sulfur dioxide?

- A. sulfur and oxygen
- B. sulfuric acid and oxygen
- C. sulfur and carbon dioxide
- D. sulfuric acid and water vapour

Question 6

Which one of the following is a significant source of sulfur dioxide?

- A. bushfires
- B. metal smelting
- C. nuclear power plants
- D. hydro-electric power plants

Question 7

The 'dosage' of sulfur dioxide gas is best described as the

- A. volume of the gas breathed in.
- B. concentration of the gas in the air.
- C. minimum mass of the gas that will cause harm.
- D. mass of the gas absorbed per unit of body weight.

Question 8

The 'toxicity' of sulfur dioxide is best described as the

- A. time the gas remains in the environment.
- B. total amount of the gas breathed in by a person.
- C. degree to which the gas can damage an organism.
- D. official classification of the gas as a pollutant.

Question 9

Which one of the following is a common impact of excessive sulfur dioxide concentrations on human health?

- A. nerve damage
- B. swollen glands
- C. loss of memory
- D. shortness of breath

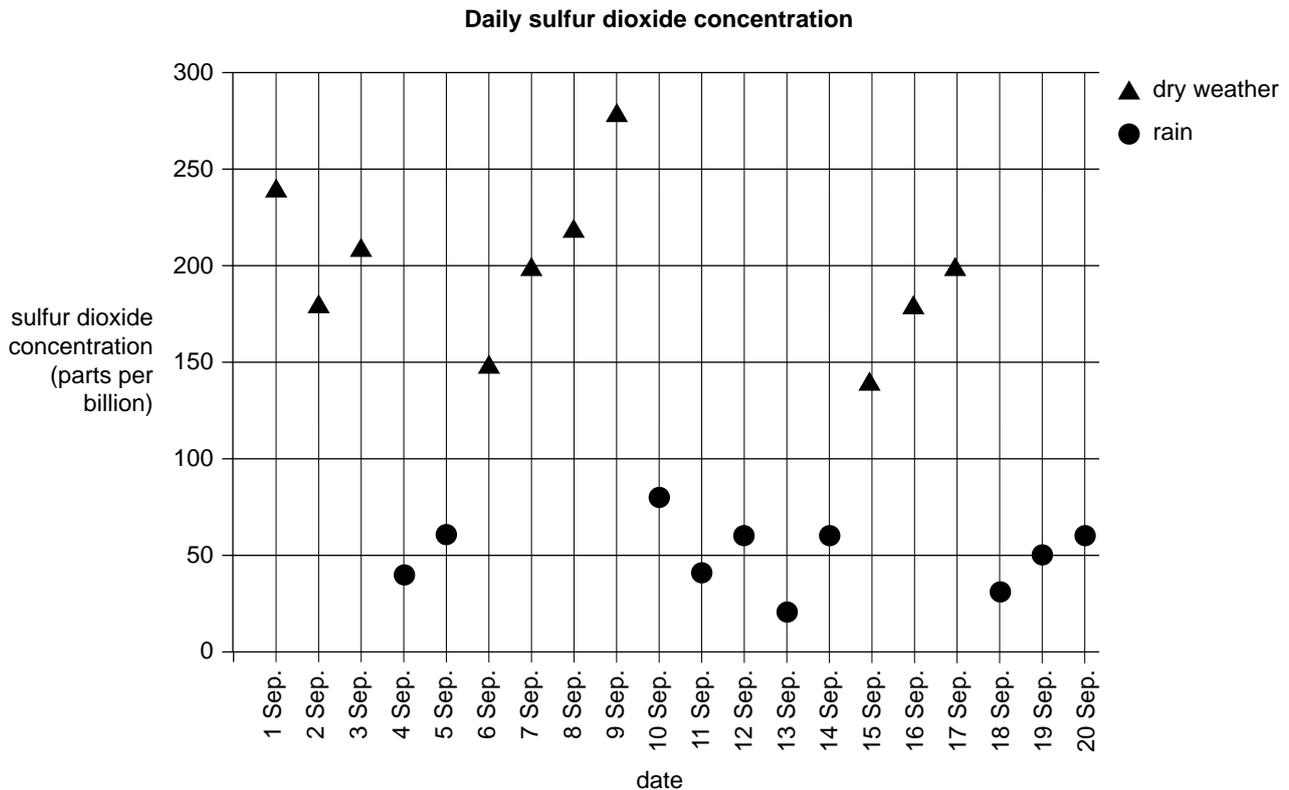
Question 10

Which one of the following techniques could reduce emissions of sulfur dioxide gas from an industrial chimney?

- A. water sprayers
- B. metallic filters
- C. high-temperature heaters
- D. electrostatic particle collectors

Use the following information to answer Questions 11 and 12.

The following graph shows sulfur dioxide concentrations measured in a town for each of 20 days, downwind of a metal ore smelter. The triangles represent measurements made on dry-weather days. The circles correspond to days on which it rained.



Question 11

The ratio of sulfur dioxide concentration on 1 September to sulfur dioxide concentration on 20 September is closest to

- A. 1:4
- B. 1:2
- C. 2:1
- D. 4:1

Question 12

The most likely explanation for the data in the graph is that

- A. rainwater dissolves sulfur dioxide gas.
- B. sulfur dioxide particles fall from the air.
- C. the weather has no impact on sulfur dioxide concentrations.
- D. wind blows sulfur dioxide away from the town on some days.

Question 13

Rob and Mary are each stung by a bee. Mary has reacted far more severely than Rob.

Mary is showing

- A. acute toxicity.
- B. chronic toxicity.
- C. an allergic reaction.
- D. a synergistic response.

Question 14

Plants help to clean water, break down pollutants and sequester carbon.

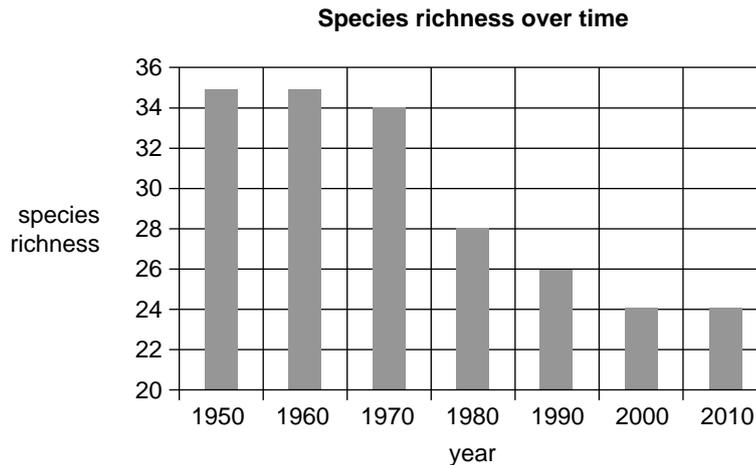
These actions are examples of

- A. land degradation.
- B. ecosystem services.
- C. human intervention.
- D. transport mechanisms.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 15–18.

The graph below shows the species richness of native grasses over time in a large quadrat within an urban park.



Question 15

A comparison of species richness between 1950 and 1960 shows

- A. a decrease in species richness.
- B. a decrease in relative abundance.
- C. that the same species are present.
- D. that the same number of species is present.

Question 16

The average species richness over the period 1950–2010 was approximately

- A. 3
- B. 26
- C. 30
- D. 210

Question 17

The percentage change in species richness between 1950 and 2010 is closest to a

- A. 31% decrease.
- B. 46% decrease.
- C. 33% increase.
- D. 45% increase.

Question 18

In 1979, an exotic weed was introduced to the urban park.

This event may have caused the change in species richness seen in the graph because of

- A. competition between species.
- B. dispersal of the native grasses.
- C. over collection of the native grasses.
- D. a decline in the abundance of herbivores.

Question 19

The construction of a tunnel that links habitats, enabling an endangered frog species to move under a major freeway, is an example of

- A. bioremediation.
- B. a wildlife corridor.
- C. remnant vegetation.
- D. habitat modification.

Question 20

Species that are endemic to a particular area are a priority for conservation measures mainly because

- A. the species provide social benefits to visitors to the area.
- B. there is only one population of the species remaining in the wild.
- C. if the members of the species in the area were to be wiped out, the species would become extinct.
- D. populations in different areas have become separated and exist only on patches of remaining vegetation.

Question 21

A company has produced a new manufacturing plan with a major focus on the concepts of 'reduce', 're-use' and 'recycle'.

This plan would be considered an example of

- A. the precautionary principle.
- B. a waste-minimisation strategy.
- C. an environmental risk assessment.
- D. an environmental impact assessment.

Question 22

An analysis of the types of shopping bags used by customers in supermarkets was undertaken. The study involved collecting data on raw materials used, energy consumption involved in manufacturing the different bags, recycling and re-using the bags, and major wastes released into the environment when the bags are disposed of.

This type of analysis would be best described as

- A. a life-cycle assessment.
- B. an environmental risk assessment.
- C. an environmental impact assessment.
- D. an environmental monitoring program.

Use the following information to answer Questions 23–26.

Ballast water is used in many ships to provide stability and balance as the ships transport goods around the oceans of the world. It is usually taken into storage tanks when ships are loading or unloading and then discharged back into the sea. This water often contains a variety of aquatic plants, animals and microorganisms. Many of these have the potential to become exotic pests if they are introduced into new marine environments.

In order to protect Victoria's marine environments from ballast water containing marine pests, regardless of its source, restrictions have been placed on the discharge of ballast water into Victorian waters. Under the *Environmental Protection Act 1970*, the government has developed a number of policies and guidelines that deal with the management of ballast water in Victoria.

Question 23

The policies and guidelines developed by the Victorian Government to control the release of ballast water are an example of

- A. a biodiversity treaty.
- B. a regulatory framework.
- C. an environmental science project.
- D. an environmental risk assessment.

Question 24

A ship owner argues that his ship should be allowed to discharge ballast water in Port Phillip Bay because the ballast water looks clean and is unlikely to contain any dangerous exotic species. However, an investigation finds that there are three seaweed species from South America in this ballast water. Their impact on Australian marine ecosystems is unknown. The ship is not permitted to discharge any of the ballast water, demonstrating an application of the precautionary principle.

In this case, to which one of the following does the precautionary principle refer?

- A. The ship owner should not be allowed to do anything that goes against the rules and laws regarding ballast water that exist in Victoria.
- B. Caution needs to be applied with any exotic pest species, such as seaweed, before the ballast water can be discharged into Port Phillip Bay.
- C. The lack of information regarding the possible environmental impacts of South American seaweed species competing with native seaweed should not be of concern.
- D. If there are potential threats of serious environmental damage from the seaweed species, lack of full scientific certainty about the impacts should not be used as a reason for postponing measures to prevent environmental degradation.

Question 25

The South American seaweed species are a potential threat to the biodiversity of Port Phillip Bay because, if released, the species could

- A. become a food source for native fish species in the bay.
- B. genetically swamp a number of the native seaweed species.
- C. compete with native seaweed species for space, light and nutrients.
- D. grow on tidal rocks around the bay and make them too slippery to walk on.

Question 26

Under the *Flora and Fauna Guarantee Act 1988*, a number of potentially threatening processes have been listed. Management strategies arising from the Act are based on scientific data because

- A. effective management requires accurate information.
- B. the collection of data provides scientists with employment.
- C. management strategies should be solely based on scientific evidence.
- D. the community needs to be involved and allowed to have some input.

Use the following information to answer Questions 27–30.

A large dam is to be constructed to allow a small hydro-electric power plant to provide the electricity supply for a small town. This hydro-electric power plant will replace the current diesel generator.

Question 27

One major environmental advantage of this change would be that hydro-electric power plants

- A. last longer than diesel generators.
- B. are cheaper to operate than diesel generators.
- C. disturb ecosystems less than diesel generators do.
- D. use a renewable energy source, while diesel is a non-renewable source.

Question 28

An environmental risk assessment of the dam is to be conducted.

The main purpose of the environmental risk assessment is to

- A. ensure maximum local employment on the project.
- B. minimise the number of people likely to object to the project.
- C. eliminate any disruption to the environment during construction.
- D. balance any environmental damage against the benefit of the construction.

Question 29

An environmental management plan is developed for the construction of the dam.

Which one of the following should be a major factor in the environmental management plan?

- A. The construction cost should be as low as possible.
- B. Long-term damage to ecosystems should be minimised.
- C. The project should be completed in the shortest possible time.
- D. Disruption to local residents should be minimised, both during construction and for future generations.

Question 30

After completion of the work, a group of scientists conducts an evaluation of the effectiveness of the environmental management plan for the project.

Which one of the following would be evidence that the environmental management plan has been successful?

- A. Electricity is cheaper.
- B. The work was completed under budget.
- C. No native animals were disturbed during the construction work.
- D. Three years later, the ecology of the area downstream of the dam is similar to the ecology of that area before the dam was constructed.

**END OF SECTION A
TURN OVER**

SECTION B**Instructions for Section B**

Answer **all** questions in the spaces provided. Write using black or blue pen.

Question 1 (12 marks)

The government of a small country has developed a plan to build three nuclear reactors to replace an ageing collection of fossil fuel power plants. These three reactors would supply electricity to a population of around nine million people. The small country has a reserve supply of the fossil fuel, estimated to allow for the production of electricity for another 15 to 20 years. Environmental groups argue that the fossil fuel power plants should be replaced totally with a variety of renewable forms of energy rather than using nuclear energy.

- a.** Explain **two** scientific reasons why the government might be considering moving from fossil fuel to nuclear energy as a source of the country's electricity supply. 2 marks

- b.** Using an energy source you have studied, explain what energy efficiency means. 2 marks

- c.** Using an example, explain how an energy source is classified as 'renewable'. 2 marks

- d. Describe why environmental groups may not be in favour of using nuclear energy to provide the country's electricity supply.

3 marks

- e. Explain why using a variety of renewable energy sources, rather than a single type, would be more effective in supplying energy.

3 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 2 (17 marks)

The temperature in the atmosphere close to the Earth's surface is determined by the greenhouse effect.

a. Explain the mechanism of the natural greenhouse effect. You should include reference to:

- energy (types of radiation) reaching Earth and what happens to it
- re-emitted radiation
- how these forms of radiation lead to the temperature on Earth.

You may include a clearly labelled diagram.

5 marks

DO NOT WRITE IN THIS AREA

- b. Explain the difference between the natural and enhanced greenhouse effects, including the main cause and impact of each.

4 marks

	Cause	Impact
Natural greenhouse effect		
Enhanced greenhouse effect		

- c. Explain the role that changes in land use have played in the enhanced greenhouse effect.

3 marks

d. Nominate a fossil fuel energy source and a non-fossil energy source you have studied.

Fossil fuel energy source _____

Non-fossil energy source _____

i. Describe the impact that the use of your fossil fuel energy source has on the enhanced greenhouse effect. Outline a mechanism for reducing this impact while still using the energy source.

3 marks

ii. In relation to the enhanced greenhouse effect, outline an environmental advantage and an environmental disadvantage of using the non-fossil energy source selected.

2 marks

DO NOT WRITE IN THIS AREA

Question 3 (18 marks)

The Australian Government's National Pollutant Inventory lists emission estimates for toxic substances, and the source and location of these emissions. One of the toxic substances listed is mercury and its compounds. In 2012–2013, Australian electricity generation led to the following listed emissions of mercury and its compounds:

- 2400 kg to the air
- 9.2 kg to water
- 0.013 kg to the land

a. Why are mercury and its compounds listed as pollutants?

2 marks

b. Describe **two** harmful effects of mercury and its compounds on people.

3 marks

c. Describe the process by which mercury emitted in electricity generation is converted into methyl mercury.

3 marks

DO NOT WRITE IN THIS AREA

d. A coal-fired power plant with one chimney produces electricity by burning brown coal.

Define the terms ‘point source of pollution’ and ‘diffuse source of pollution’. State, with a reason, whether this coal-fired power plant is a point source or diffuse source of mercury.

3 marks

e. Sarah states that it is only the emissions of mercury to water that are a problem for fish and shellfish. She maintains that there should be no concerns regarding the far greater emissions to the air from the generation of electricity.

State, with reasons, whether Sarah is correct or incorrect.

3 marks

DO NOT WRITE IN THIS AREA

- f. Using mercury and its compounds as an example, define the terms 'persistence' and 'mobility'. In your answer, state whether mercury and its compounds have high or low persistence and high or low mobility.

4 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 4 (14 marks)

The Sun Bear, *Helarctos malayanus*, is a species of small bear that is found in scattered tropical forests throughout South-East Asia. Its name, Sun Bear, derives from the crescent-shaped markings on its chest, which are thought to look like the rising or setting sun. Sun Bears consume a diet of mainly insects and fruit but can also feed on honey. They have a long protruding tongue that is used for removing honey from bee hives high in the trees. Females give birth within the safety of fallen hollow trees. Male and female bears have been observed making sleeping platforms high above the ground, using branches and leaves.

Illegal logging is a difficult practice to control in areas of South-East Asia.

Parts of the bears, for example the gall bladder, are sought after as traditional medicines.

- a. The Sun Bear has been included for listing under CITES.

What does CITES stand for and what type of protection will this provide the bear species?

2 marks

- b. State the main threat to the Sun Bear. What is the possible impact of this threat on the range of this species?

2 marks

- c. There is limited population data on the Sun Bear.

Describe a suitable strategy for monitoring the population.

2 marks

d. In 2008, the International Union for Conservation of Nature (IUCN) classified the Sun Bear as vulnerable.

i. If the bear population has reduced by half since 2008, what new IUCN classification could the bears be given?

1 mark

ii. This reduced population size would also mean a decrease in the genetic diversity of the species.

Define 'genetic diversity' and provide **one** negative consequence of this decrease.

3 marks

e. Four Sun Bears currently live in a zoo in North America. Zookeepers claim that this management practice will ensure the long-term survival of the species.

Evaluate this claim, providing the advantages and disadvantages of captive breeding.

4 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 5 (16 marks)

Two scientists are conducting an environmental impact assessment (EIA) of a project to clear a large woodland area for farmland.

- a.** Outline **three** reasons for conducting an EIA prior to gaining approval for the project. 3 marks

As part of the EIA, the scientists study a similar woodland area in a different part of the country that was cleared 10 years ago. This area has some isolated patches of woodland left between farms. The scientists study three of these – areas A, B and C.

- b.** State the scientific term for these patches of woodland. 1 mark

- c.** Give **one** reason for and **one** reason against this strategy of studying a similar area in a different part of the country. 2 marks

The scientists are particularly interested in the impact of the project on bird species. Hence they sample the bird populations in the three areas and record the data shown in Table 1.

Table 1

Species	Number of individuals counted		
	Area A	Area B	Area C
Galah	40	50	28
Australian Magpie	60	30	0
Eastern Rosella	20	40	36
Noisy Miner	40	120	36
Gang-gang Cockatoo	40	10	20

- d. Identify which of the areas, A, B or C, has the lowest species richness. Explain your answer, making clear the meaning of 'species richness'.

2 marks

The scientists use an index of biodiversity (species diversity). This index is calculated as follows.

$$I = \frac{(\text{sum of differences from mean of each species present [positive value]})}{(\text{number of species in sample area}) \times (\text{total number of individuals in sample area})}$$

The calculation for the index for Area B is shown in Table 2.

Table 2

Species	Area B	Difference from mean (mean – number)
Galah	50	0
Australian Magpie	30	20
Eastern Rosella	40	10
Noisy Miner	120	70
Gang-gang Cockatoo	10	40

A lower index means greater biodiversity (species diversity).

$$\text{mean} = \frac{(50 + 30 + 40 + 120 + 10)}{5} = \frac{250}{5} = 50$$

$$\text{sum of difference from mean} = 0 + 20 + 10 + 70 + 40 = 140$$

$$\text{number of species} = 5$$

$$\text{total number of individuals} = 50 + 30 + 40 + 120 + 10 = 250$$

$$I = \frac{140}{5} \div 250 = \mathbf{0.112}$$

The index for Area C is also calculated and found to be **0.050**

- e. Based on the calculations and data in Table 1 and Table 2, identify which of areas B or C has the greatest biodiversity. Justify your answer.

2 marks

- f. Looking at the index and the calculations, describe the factors that have been taken into account when measuring species diversity.

3 marks

- g. Calculate the index for Area A. Explain what this figure indicates.

3 marks

Species	Area A	Difference from mean
Galah	40	
Australian Magpie	60	
Eastern Rosella	20	
Noisy Miner	40	
Gang-gang Cockatoo	40	

Calculation

Explanation

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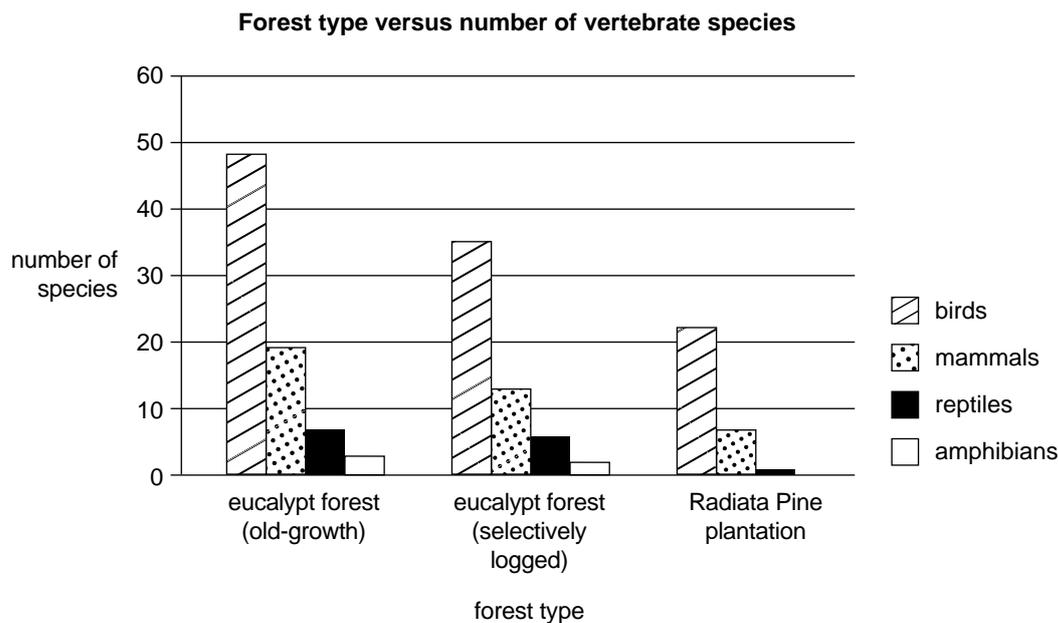
Question 6 (13 marks)**Proposal 1: Selective logging**

A plan has been developed to selectively log an area of old-growth native forest ('old growth' refers to an ecologically mature forest with minimal human disturbance). Selective logging focuses on removing certain useful species and specific trees from the forest (up to three or four trees per hectare), but leaves most of the other trees and understorey vegetation standing. The plan is to use the wood for high-value timber purposes, such as furniture, flooring and boat building. After the selective removal of certain trees, native vegetation would be allowed to regenerate through natural processes.

Proposal 2: Clear felling and developing a Radiata Pine plantation

An alternative proposal has been suggested to progressively clear-fell the whole forest ('clear-felling' refers to the removal of all trees in the area in a single harvest) and use the wood for chips, which would be exported overseas and made into paper. The clear-felled land would then be revegetated with a Radiata Pine plantation (a North American tree species). This species of tree grows more rapidly than many native trees (up to 10 times faster than eucalypts) and can produce larger yields of timber in a shorter period of time. Under certain conditions, the growth rate of this species of tree also leads to more carbon dioxide being absorbed. Radiata Pine is mainly used in housing construction and can be chipped to make particle board and newspaper pulp.

Concerns have been expressed about the impacts of sediment run-off into the local creek system and water reservoir from clear-felling the land. The reservoir is the main water supply for towns in the region. The old-growth forest provides a habitat for a more diverse range of species (see Figure 1) and the potential decrease in species diversity due to logging is a concern for environmental groups.

**Figure 1**

The region where the logging is to take place currently has high levels of unemployment and the selective logging option is estimated to bring in \$3.4 million per year. Clear-felling, then exporting the wood chips and developing a Radiata Pine plantation, would generate around \$4.2 million in revenue annually. Local business groups have suggested that rather than clear-felling occurring, the selectively logged forest should be conserved. A major source of income could then be generated by developing an environmentally sensitive tourism centre with accommodation and educational facilities.

- a. Which of the two proposals on page 24 could be described as the more ecologically sustainable development? Justify your answer by using the key principles of ecologically sustainable development.

3 marks

- b. Describe a process that could be used to determine whether or not development should be allowed to proceed.

2 marks

- c. Identify **two** key stakeholders that might be involved in this decision-making process. What would their roles in this process be?

3 marks

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